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Haddock
Melanogrammus aeglefinus

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The haddock is a demersal gadoid found on both sides of the North Atlantic; in the Northwest Atlantic, they occur from West Greenland to Cape Hatteras, and are most common in water temperatures of 2-10°C (36-50°F) and at depths of 45-135 m (Bigelow and Schroeder 1953). In U.S. waters, two stocks from the Gulf of Maine and on Georges Bank have been recognized (Clark et al. 1982). Although Georges Bank haddock are relatively sedentary, seasonal coastal migrations are known to occur in the western Gulf of Maine.

Growth rates for males and females are similar. Haddock become sexually mature at age 2 or 3, with individual females producing up to 3 million eggs. Spawning occurs from January through June, with peak activity in late March and April. A maximum age of 18 years has been documented for Georges Bank, although fish greater than 9 years of age are uncommon. Haddock attain lengths of 75-80 cm (30-32 inches) and weights to 5 kg (11 pounds).

Scales have been used for age determinations for haddock taken off North America since the early 1900's. Kohler and Clark (1958) compared age determinations based on scales and otoliths and reported no significant differences up to about 7 years; but thereafter, scale readings were consistently lower than otolith readings. Jensen and Wise (1962) subsequently validated the use of scales for haddock, particularly during their first 5 years of life. Scales are currently used at the Woods Hole Laboratory, because they are easier to work with, but age determinations can be readily made from both scales and otoliths over the range of ages normally present.

Scales are removed from the lateral line region anterior to the caudal peduncle for dry storage. About 5 or 6 scales from each fish are impressed on a laminated plastic slide by a roller press and viewed on a microprojector using transmitted light at a magnification of about 40×. Regenerated scales are discarded.

The scales are cycloid, oval or elliptical in shape, with no radii or transverse grooves (Figs. 1 and 2). The outer surface is sculptured with concentric rings of circuli, comprised of individual platelets, but the inner surface is smooth. The focus is generally anterior to the center of the scale, and growth zones are most clearly defined on the posterior portion of the scale. Generally, a pie-shaped sector from the longest portion of the scale, starting at the focus and extending to 15° on either side of the center of the posterior edge, is the area preferred for age determination. The spacing of circuli and shape of the platelets indicate periods of rapid and slow growth. Rapid summer-type growth is characterized by circuli which are spaced relatively far apart and are composed of platelets with curved edges. Slow winter-type growth is characterized by closely spaced circuli which are composed of platelets with straight edges (Fig. 3).

The annulus is defined as a zone of close winter circuli marking the end of a year of growth, i.e., the winter growth zone. Jensen and Wise (1962) report the following characteristics: 1) the annulus is concentric with the margin of the scale; 2) it can be traced, by careful scrutiny if necessary, entirely around the scale; 3) it is clearly separated from other such zones and does not ordinarily meet them at any point; and 4) if present, it is on all the normal scales of an individual.

By convention, a 1 January birthdate is used; therefore, a winter growth zone forming on the edge of the scale is designated as an annulus on 1 January, even though the zone is not complete.

Summer-type edge generally forms during May-July (Fig. 4), with winter-type growth predominating during August-April (Figs. 5, 6, 7, 8). Older fish begin forming summer-type edge growth later than younger fish and start winter-type growth earlier.

A major pattern feature in the differentiation of an annulus is the number of circuli per unit area. The number increases during slow winter growth and decreases during rapid summer growth. Measurement of the distance between circuli shows relatively wide interspaces during rapid summer growth, and as the interspace decreases, compaction of the circuli forms the broad, dark-appearing rings that represent the period of slow winter growth (Fig. 5). The end of an annulus (i.e., the last true winter circulus in the winter growth zone) is generally followed by a rapid transition from narrow to widening interspaces, signifying the start of the next period of rapid summer growth. This usually occurs in the spring of the year, but can vary in different geographical areas. Number of circuli per unit area and circuli interspaces are useful in determining the first few annuli, but after the fifth or sixth annulus, there is a gradual reduction in the number of the circuli formed during a year's growth. This diminishes the usefulness of these two methods.

Changes in the shape of the individual platelets forming the circuli are also useful in recognizing an annulus, especially after the fifth or sixth year. The outline of platelets formed during summer growth are frequently curved or crescent-shaped, while winter platelets tend to be straight. Scanning electron microscopy (SEM) reveals this to be caused by greater protrusion of the summer platelets from the basal plate. They also have a rounded upper edge, while winter platelets have a relatively straight upper edge (Fig. 3).

Checks may be distinguished from annuli by relative width, location, and platelet shape (true winter platelets may not be formed) (Figs. 2, 4, 6, 9). Although checks generally begin abruptly, annuli usually have a transition zone showing a relative decreasing of the interspace between circuli before the true winter zone is reached (Figs. 4 and 6). Absence of a rapid transition to summer growth after the check may also help to distinguish it from an annulus (Fig. 9). Checks may also be distinguished by following them around towards the sides of the scale to determine if they merge with an annulus to form one zone. Checks may be stronger on some scales and weaker, or even absent, on others, while annuli are present on all scales from a particular fish. This is one reason why several scales are examined from each fish in order to verify the assigned age. It is sometimes necessary to make two or three impressions, of 5 or 6 scales each, before a clear "composite" picture of the fish's growth can be determined.

Spacing of the annuli relative to each other and to the focus of the scale may be used to differentiate between annuli and checks. For example, if two winter growth zones are found relatively close together on a scale from a younger fish, but all the other winter zones on the scale are relatively far apart, then one of the two close zones will probably be a check and not an annulus. This type of annulus construction (i.e., two close zones) is generally described as a split annulus due to difficulty in differentiating between the check and the annulus (Figs. 2, 4, 7, 8). On scales from older fish, annuli formed after the fifth or sixth year are expected to be fairly close together (Figs. 5, 9, 10).

Characteristic patterns based on geographic origin are useful for identifying annuli. Fish from Georges Bank often have a characteristic check, called a false annulus, before the first annulus. This may be distinguished from a true annulus by the number of circuli contained between the focus of the scale and the end of the false annulus (generally 10-16 circuli) (Figs. 2, 4, 8). These fish also grow more rapidly during their first and second years than do fish from other areas, so that larger first and second annuli are expected on these scales compared with scales from Gulf of Maine or Browns Bank fish. Georges Bank haddock scales also show more distinctly formed annuli than do fish from the Gulf of Maine, which often exhibit annuli lacking winter platelets with straight edges (Figs. 1 and 2). This presents some difficulty in ageing Gulf of Maine fish as often only circuli spacing and relative annuli spacing can be used as age determination criteria. Moving back from the microprojector screen for a better perspective of the overall pattern of growth often permits an easier age interpretation.

Rapid first, second, and third-year growth followed by gradually slower growth in later years by Georges Bank haddock is in contrast to Browns Bank fish (Schuck and Arnold 1951, Wise 1957). They exhibit comparatively slow growth during the first three years, followed by more rapid growth in the fourth, fifth and sixth years, and then a gradual slow down in growth in subsequent years (Figs. 10 and 11).

Recognition of checks caused by damage or injury to haddock is a problem in ageing fish from all areas. In these cases, the scale is physically shifted in the scale pocket, resulting in subsequent circuli that are not quite in line with previous circuli, "lost" circuli, and irregular spaces (Fig. 7). Circuli in the damaged area may disappear when an attempt is made to trace them around the scale. These marks on the scale correspond to the area of regeneration after the scale was lost. The effect is similar to that known as "cutting over," caused by erosion of the scale edge, which is commonly seen with flounder and certain other species' scales.

The relative location of annuli is the most reliable general criterion for discriminating between checks and annuli for haddock scales. An initial procedure that is useful during scale examinations is to mentally superimpose a regular growth pattern, based on prior knowledge of typical patterns for the geographic origin of the fish. Any zone not fitting the pattern is closely scrutinized to determine if it is a check.

On occasion, particular year-classes may exhibit peculiar growth characteristics which assist in determining age. The 1960 year-class on Georges Bank exhibited very regular growth patterns with no checks (Fig. 5). Other year-classes may form a certain split annulus, or a strong check between two particular annuli, or perhaps two close annuli. Such characteristic growth patterns may be very useful in assigning the most probable age, particularly for difficult specimens.

Citations

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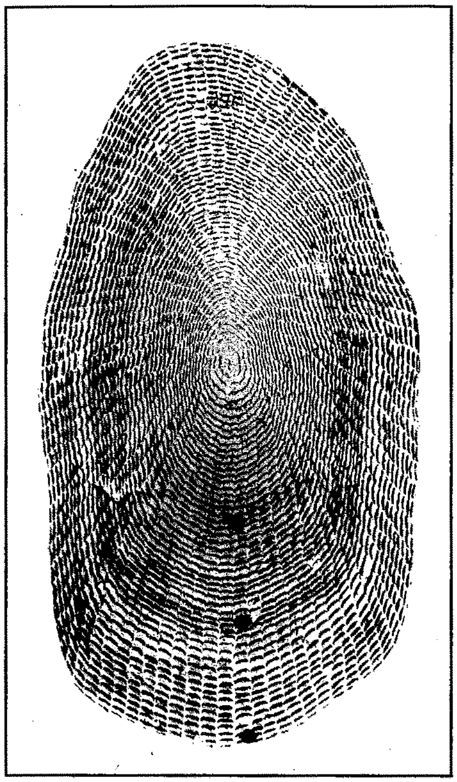

Figure 1
Scale impression of a 41-cm age-3 haddock collected in January from the Gulf of Maine showing the poorly differentiated annuli typical for this area.

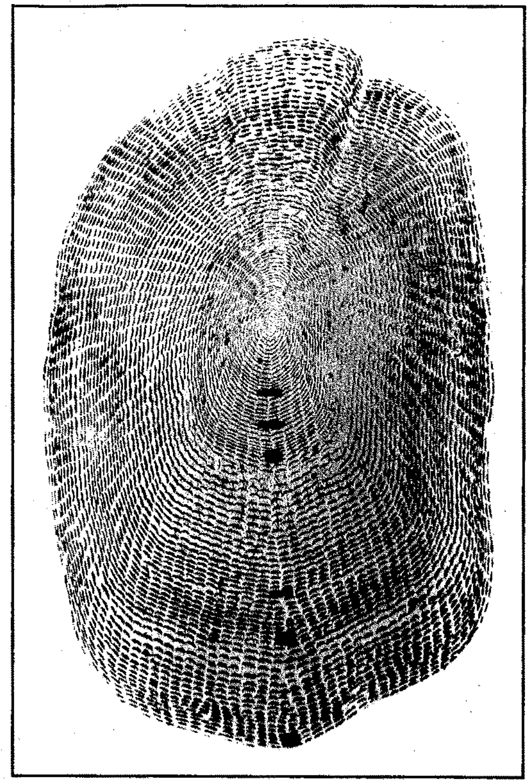

Figure 2
Scale impression of a 47-cm age-3 haddock collected in January from Georges Bank showing a checky first year (with a false annulus) and a split second annulus.

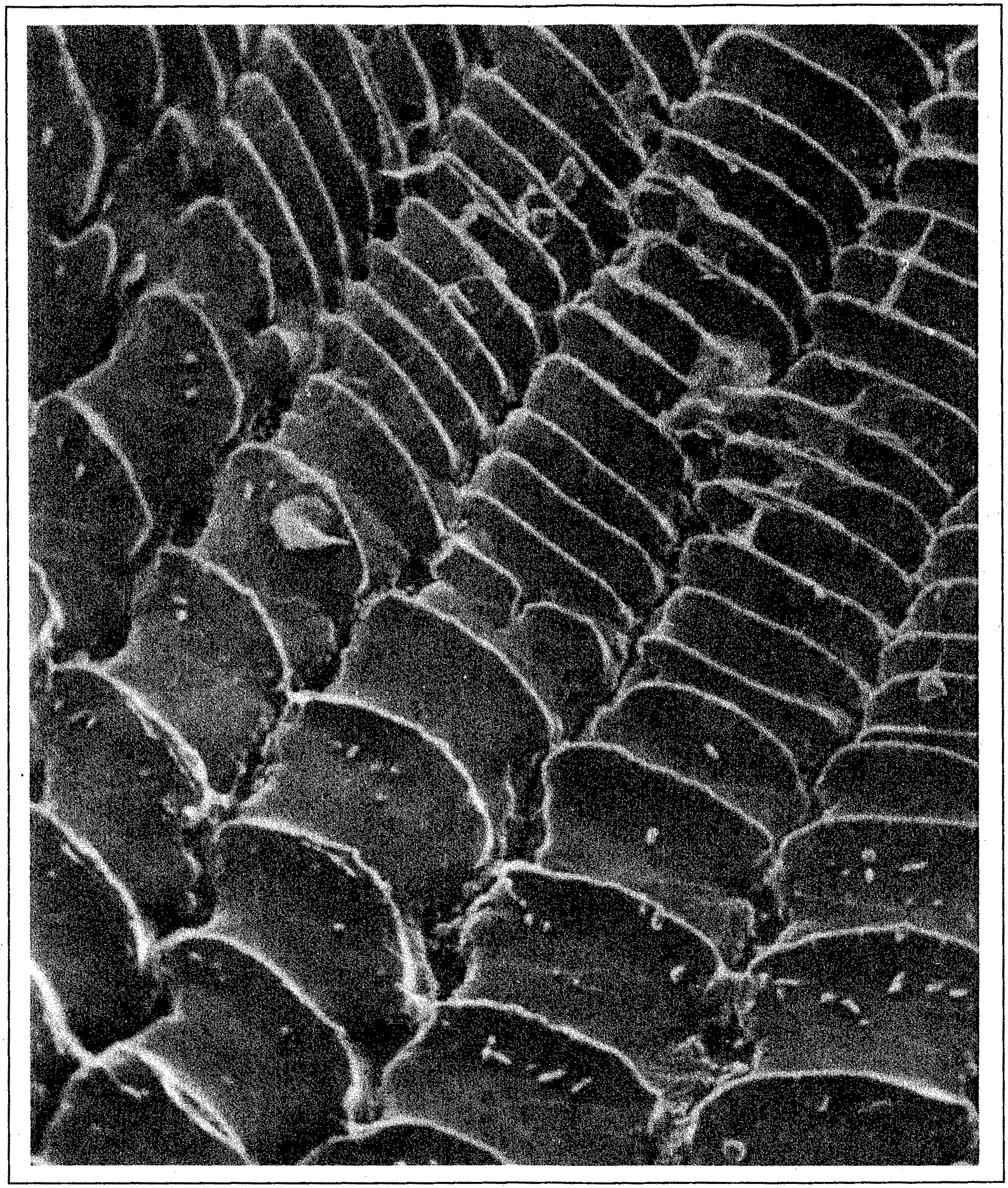

Figure 3
SEM photograph of an actual haddock scale showing summer platelets with curved edges and winter platelets with straight edges.

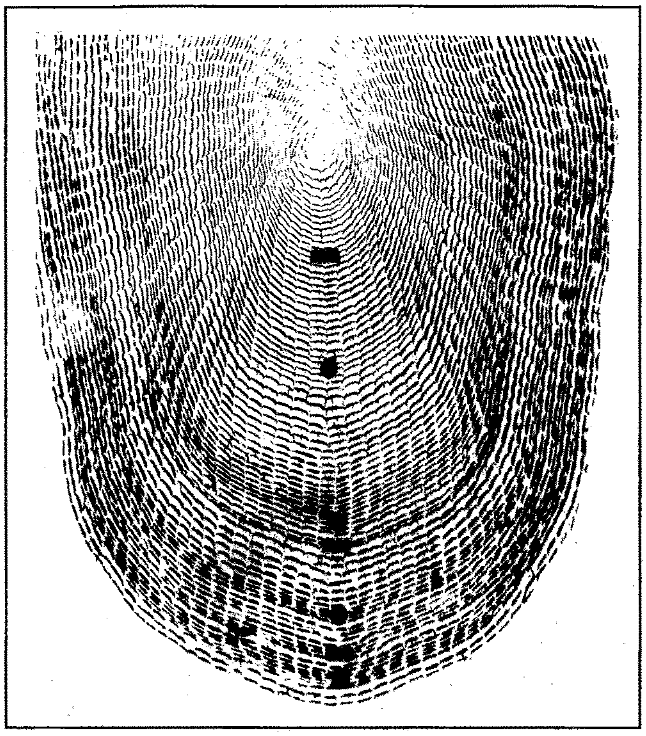

Figure 4
Scale impression of a 52-cm age-4 haddock collected in June from Georges Bank showing a false annulus, a split second annulus, and a strong check before the fourth annulus, with summer edge forming.

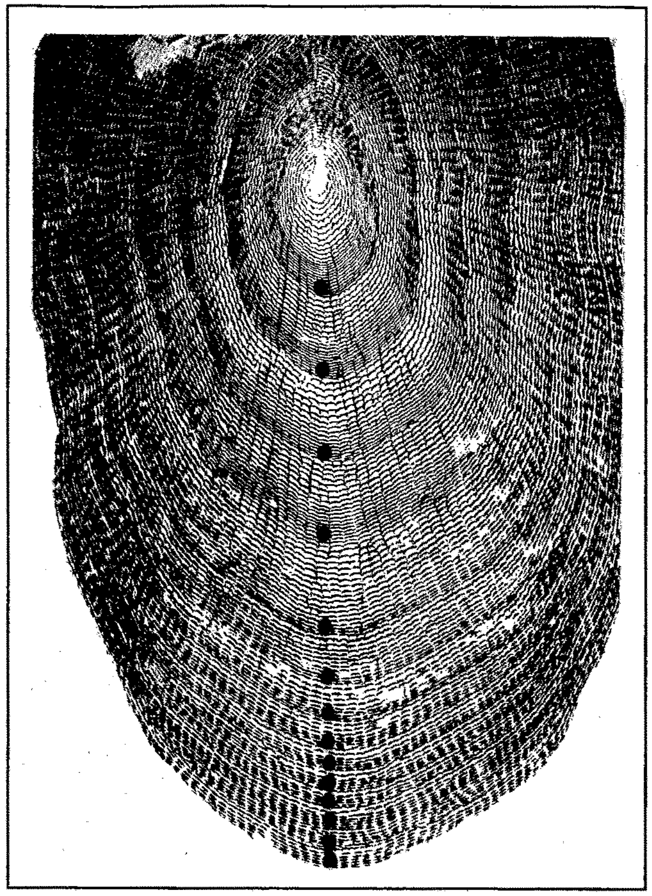

Figure 5
Scale impression of a 74-cm age-14 haddock collected in April from Georges Bank showing a "textbook" pattern of extremely regular annuli formed by alternating zones of rapid summer and slow winter growth.

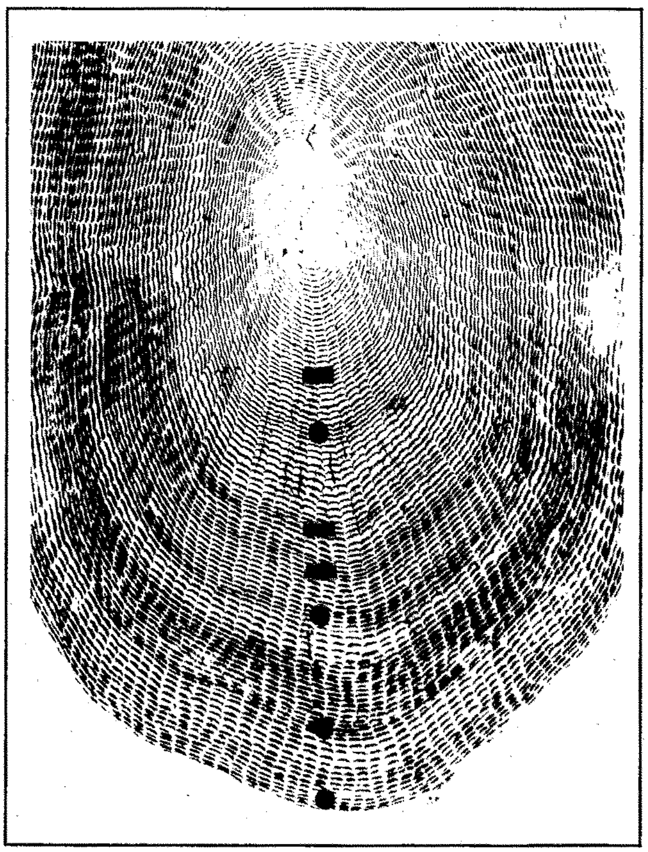

Figure 6
Scale impression of a 64-cm age-4 haddock collected in January from Georges Bank showing very checky first and second years, with winter edge forming.

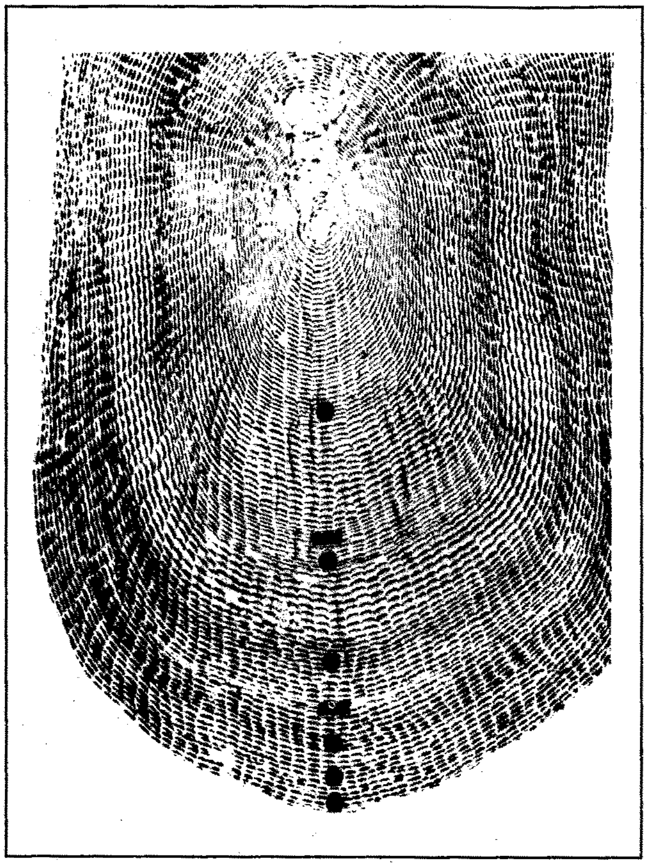

Figure 7

Scale impression of a 60-cm age-6(5) haddock collected in February from Georges Bank showing a split second annulus, a check (caused by damage or injury to the fish) between the third and fourth annuli, and a weak fifth annulus, with the sixth annulus forming on the edge.

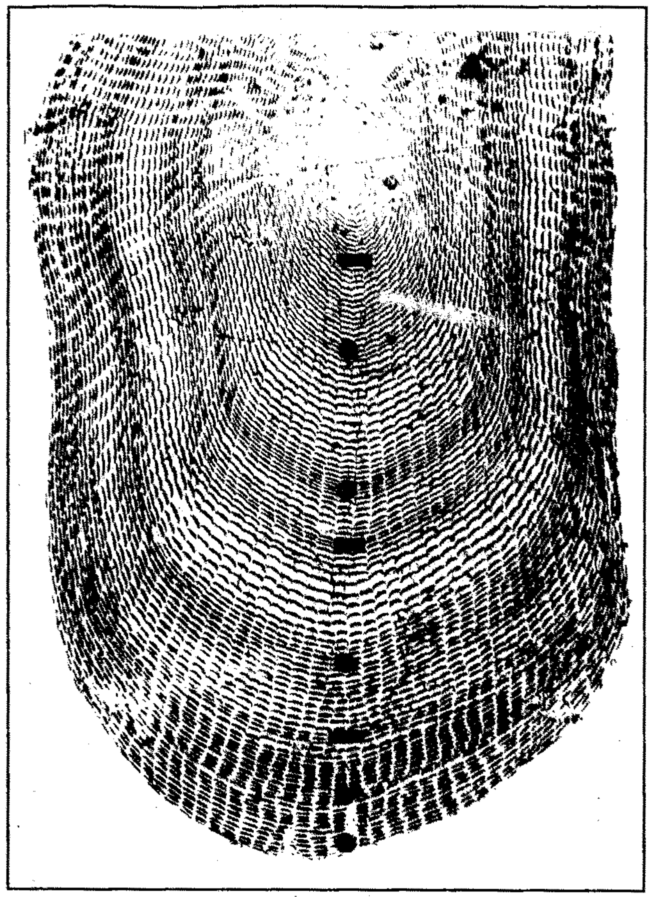

Figure 8

Scale impression of a 64-cm age-5 haddock collected in February from Georges Bank showing a false annulus, split second annulus, weak third annulus, split fourth annulus, with the fifth annulus forming on the edge.

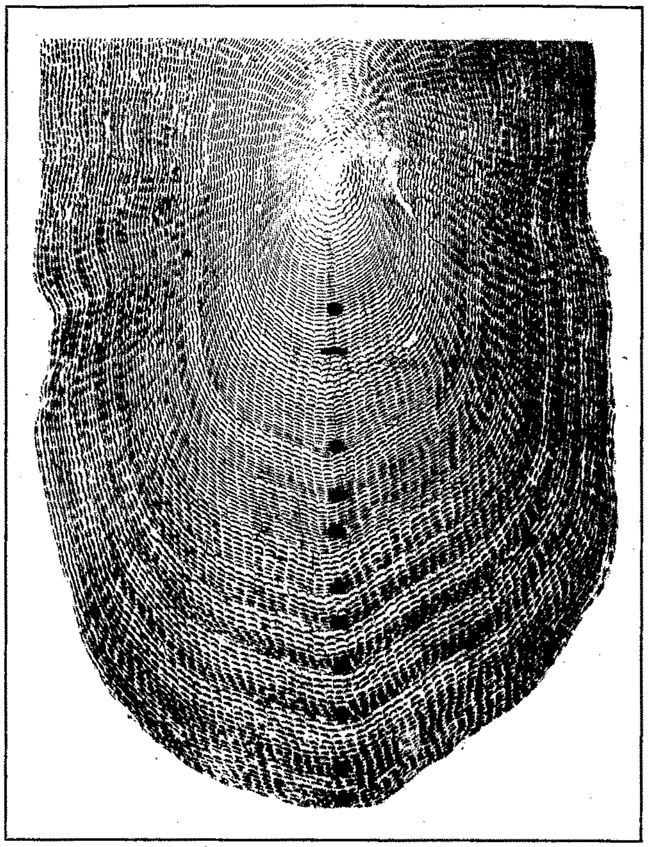

Figure 9
Scale impression of a 68-cm age-10 haddock collected in February from Georges Bank showing a check after the first annulus and close third and fourth annuli.

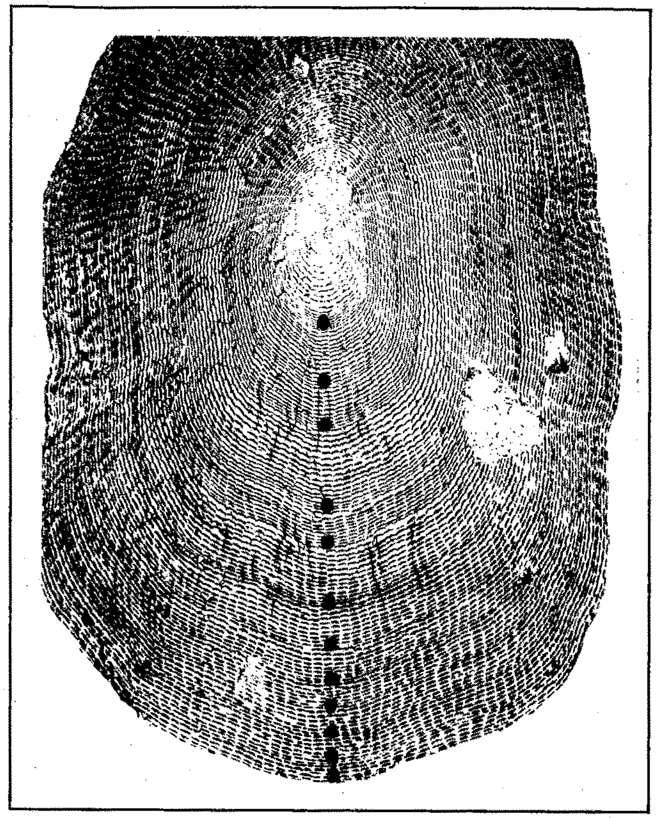

Figure 10
Scale impression of a 66-cm age-12 haddock collected in January from Browns Bank showing the close first, second, and third annuli typical for this area.

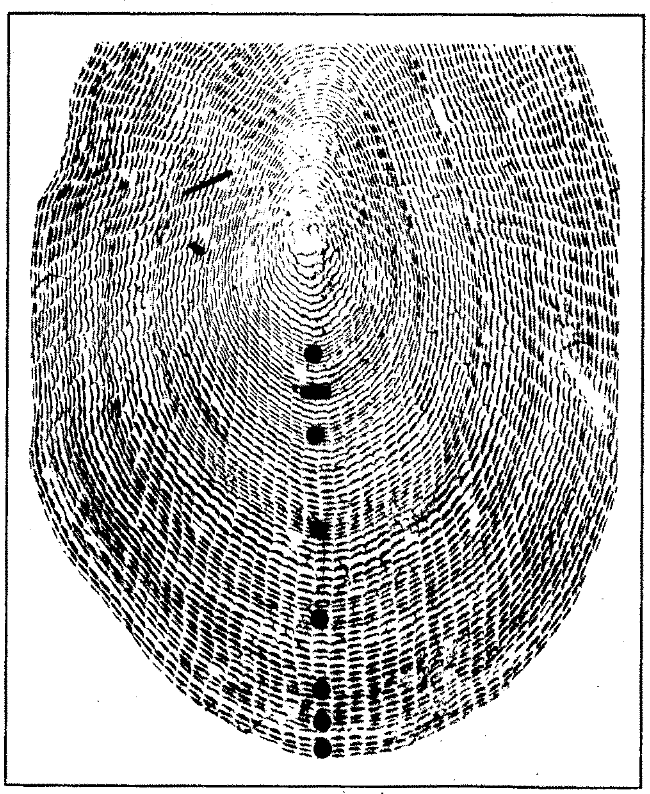

Figure 11
Scale impression of a 54-cm age-7 haddock collected in February from Browns Bank showing the close first, second, and third annuli typical for this area.